Technical Report No. 50 / Rapport technique no. 50

THE NAIRU IN CANADA: Concepts, determinants and estimates

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Bank of Canada Banque du Canada

December 1988

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The views expressed in this paper are the responsibility of the author and of the other contributors to this work and do not necessarily reflect those of the Bank of Canada.

The author is responsible for the paper as a whole, but the content has an intricate parentage. The paper uses results from empirical work done in the Research Department by Jacques Pelletier, Robert Ford, Dave Moloney, Douglas Laxton, Jean-Pierre Aubry and Serena Ng. It has also been influenced substantially by the views and comments of colleagues too numerous to mention specifically. Paul Jenkins has provided continuous encouragement and much help with the arguments and exposition. Christine Banham provided reliable research assistance. The editorial input of Maura Giuliani has made the text much more readable.

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ABSTRACT

An important question that faces macroeconomic policy makers is whether the economy can absorb increases in aggregate demand without generating inflationary pressures. Many economists have found it useful to approach this issue by asking whether the economy is operating at a rate of unemployment consistent with inflation neither accelerating nor decelerating, all else being equal. This rate is widely referred to as the NAIRU, an acronym from *n*on-*a*ccelerating-*i*nflation *r*ate of *u*nemployment.

This paper reviews the determinants of the NAIRU, why it may change over time, and various methodologies that have been used to measure it. The discussion of determinants considers: factors that influence the incentives to be in the labour force and to work (such as the effect of unemployment insurance); aspects of the composition of the labour force (such as age and gender); particular supply factors (such as the role of unions); and temporary structural influences in the economy (such as response to major relative price changes). The discussion of methodology covers: reduced-form unemployment equations; the Phillips curve (for price as well as wage inflation) and Okun's Law; and new work at the Bank of Canada that combines Okun's Law, a production function and the Phillips curve in a simultaneously estimated system.

Recent work in the Bank of Canada Research Department concerning the NAIRU is summarized, and estimates and methodologies are compared with those of other researchers. The point estimates range widely and, in general, are not statistically well determined. We show that the same uncertainty surrounds the point estimates presented by other researchers. Therefore, an element of judgment is required in drawing any conclusions from the empirical work. The judgment reached in this paper is that the NAIRU for Canada at the end of 1987 was about 8 per cent, and that there are factors working to reduce it over the medium term.

RÉSUMÉ

Les décideurs des politiques macroéconomiques doivent répondre à une question importante, à savoir si l'économie est en mesure d'absorber les accroissements de la demande globale sans provoquer de pressions inflationnistes. De nombreux économistes ont trouvé utile d'aborder cette question en se demandant si le taux de chômage auquel fonctionne l'économie est compatible avec un taux d'inflation qui ne s'accélère ni ne ralentit, toutes choses égales par ailleurs. On emploie généralement le sigle TCNA pour désigner ce taux de chômage non accélérationniste.

La présente étude passe en revue les déterminants du TCNA, les raisons de ses variations possibles au fil du temps et les diverses méthodes qui ont servi à le mesurer. Les déterminants en question sont les suivants : les facteurs qui influencent la décision des gens de faire partie de la population active et d'occuper un emploi, tels que les effets de l'assurance-chômage; certains aspects de la composition de la main-d'oeuvre, comme l'âge et le sexe; des facteurs particuliers ayant trait à l'offre, comme le rôle des syndicats; et des facteurs structurels transitoires, comme les réactions aux variations importantes des prix relatifs. La discussion de la méthode concerne les équations de forme réduite relatives au chômage; la courbe de Phillips (appliquée aux hausses de prix et de salaire) et la loi d'Okun; et de nouveaux travaux de recherches effectués à la Banque du Canada, qui réunissent dans une méthode d'estimation simultanée la loi d'Okun, une fonction de production et la courbe de Phillips.

La présente étude comprend une synthèse des récents travaux effectués au département des Recherches sur le TCNA, et les estimations et les méthodes qu'elle expose sont comparées avec celles d'autres chercheurs. Nos estimations ponctuelles affichent de grandes variations et en général elles ne sont pas statistiquement bien déterminées. Nous montrons que les estimations ponctuelles présentées par les autres chercheurs sont entourées de la même incertitude. Aussi faut-il faire preuve de discernement en ce qui concerne les conclusions à tirer des travaux empiriques. Selon les résultats de cette étude, le TCNA pour le Canada à la fin de 1987 a été d'environ 8%, et des facteurs sont à l'oeuvre pour le réduire à moyen terme.

1. INTRODUCTION

An important question that faces macroeconomic policy makers is whether sufficient slack exists in labour and product markets to absorb increases in aggregate demand and declines in the unemployment rate without generating inflationary pressures. Many economists have found it useful to approach this issue by asking whether the economy is operating at a rate of unemployment consistent with inflation neither accelerating nor decelerating, all else being equal. This rate is widely referred to as the NAIRU, an acronym from *n*on-*a*ccelerating-*i*nflation *r*ate of *u*nemployment.

This paper reviews the determinants of the NAIRU, why it may change over time, and various methodologies that have been used to measure it. Recent work by staff of the Research Department of the Bank of Canada concerning the NAIRU is summarized, and estimates and methodologies are compared with those of other researchers. An attempt is made to identify the sources of differing views on the NAIRU, in terms of aspects of methodology, measurement of data, etc., that lead to different econometric estimates.

The point estimates presented here range widely and are, in general, not statistically well determined. We show that the same uncertainty surrounds the point estimates presented by other researchers. An important message of the paper is that the data and methods of macroeconometrics are not capable of providing precise answers as to the level of the NAIRU. Therefore, an element of judgment is required in drawing any conclusions from the empirical work. The judgment reached in this paper is that the NAIRU for Canada at the end of 1987 was about 8 per cent, and that there are factors working to reduce it over the medium term.

2. THE CONCEPT OF A NON-ACCELERATING-INFLATION RATE OF UNEMPLOYMENT (NAIRU)

The concept of an equilibrium rate of unemployment became prominent in modern macroeconomics following the contributions of Phelps (1967) and especially Friedman (1968). They called it the "natural" rate of unemployment. It was defined as the rate of unemployment that would be observed in a Walrasian general equilibrium, given the existing structure of markets and institutions. There was no attention to distinguishing short-term from long-term equilibrium. These writers wanted to make the point that equilibrium unemployment is determined by forces in the real economy and is essentially independent of the level of inflation. They argued that the simple Phillips curve (with its trade-off between unemployment and wage inflation) ignores the adjustment of inflation expectations and that the expectations-augmented Phillips curve is vertical at the "natural" rate of unemployment, except when people are fooled by accelerating (or decelerating) inflation. The accelerationist hypothesis -- that the rate of unemployment cannot be held below the "natural" level by aggregate demand stimulation without generating ever-accelerating inflation -- was central to their argument that monetary policy should focus on longer-term price stability and not attempt to "fine tune" in response to real cycles or, worse, to target on a real variable.

This ignited a debate on whether a trade-off exists between inflation and unemployment in the short run. Many Keynesians, led by Robert Solow (e.g. 1969), although ready to accept the importance of expectations, maintained that there is an exploitable trade-off over the policy horizon. For several reasons, the accelerationist view prevailed: partly because it was not grossly at odds with the empirical evidence; partly because some respected theorists, notably Lucas (1972,1973) and Sargent and Wallace (1973,1975), showed that in some rational expectations models monetary policy could not influence the real economy even in the short run; and partly because inflation began to overshadow unemployment as a policy concern. In any case, the concept of a natural or equilibrium rate of unemployment has become part of the macroeconomist's toolbox and has been widely used in debates about policy.

Although the earlier literature did not focus on the time horizon in defining a "natural" equilibrium, more recent work has emphasized that there may be an important difference between what emerges in steady state and what is feasible in the short run, when an economy is adjusting to shocks. For example, when there is a relative price change that necessitates structural readjustment in an economy, there may be an inevitable period of higher unemployment as workers learn new skills or relocate. In the interim, general demand stimulus will help the declining sectors only slightly and will likely create net inflationary pressures. In this case one must distinguish

between the unemployment rate that will emerge once the resource reallocation has occurred (the long-term equilibrium rate) and the rate consistent with unchanged inflation over the adjustment period (i.e. the non-accelerating-inflation rate of unemployment or NAIRU).[1]

In recent years there has been intense debate over the nature of unemployment and its policy implications. Most economists would agree that unemployment can be influenced in the short run by many factors that have little or no effect on the long-term equilibrium unemployment rate. Where they disagree is over interpretation of the data from a policy perspective. On the one side, economists who stress a real equilibrium view of the business cycle argue that most observed movements in rates of unemployment are either mismeasurements or natural equilibrium response to shocks (e.g. Prescott 1986, Wright 1986). In extreme versions of this thinking, the observed rate is the NAIRU and there is no significant issue for monetary policy. On the other side, Keynesians tend to think that most unemployment is what it appears to be -- involuntary and the result of disequilibrium conditions -- and that there is indeed a macroeconomic policy issue. In extreme versions of this approach, most movements in actual unemployment reflect aggregate demand cycles and the NAIRU is relatively stable. Most economists would probably take a middle ground, arguing that many shocks do cause the NAIRU to move with the actual unemployment rate, but that there is nonetheless a significant Keynesian demand component to the unemployment cycle.

The research reported in this paper is motivated by the Bank of Canada's desire to understand the inflation dynamics in the Canadian economy from a macroeconomic policy perspective. Therefore, the focus is not primarily on the long run, but rather on the short- to medium-term pressures on wage and price inflation and what we have called the NAIRU view of the "natural" rate. Because of the clear link to inflation, we have chosen to use the term NAIRU in this report. There does not seem to be a consensus in the literature on terminology; many researchers use the term "natural rate" in discussing short- to medium-term issues. Therefore, in some cases what we have reported as estimates of the NAIRU were called "natural rates" in the original research.

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1 The long-term equilibrium rate of unemployment can be influenced by government policies. Indeed, the Macdonald Commission recommended several "structural" (i.e. not macroeconomic) policy initiatives explicitly designed to improve the efficiency of the economy and to lower the NAIRU.

3. DETERMINANTS OF THE NAIRU

3.1 Overview

Economists have identified many factors that may influence the NAIRU. In this overview, some of the main ones are introduced. The subsequent discussion provides further detail on the arguments and evidence.

At any point in time there will be workers in the process of changing jobs. Modern search theory has attempted to formalize the traditional notion of "frictional" unemployment in an effort to identify what might affect its level. One determinant often cited is the nature of support programs for the unemployed. The willingness to hold out for a better job offer will depend on the income sacrificed in the short run, relative to expected gains in the future. If assistance is available to the unemployed, they are likely to wait longer.[2]

Another factor is demographics. If the age structure of the work force is changing, and if workers are not homogeneous, either because of their supply behaviour or because they are not perfect substitutes in production, there may be changes in the equilibrium rate of unemployment. The same argument has been applied to gender (in light of the significant upward trend in female participation over the past 30 years). These arguments can be presented in "level" form, where segments of the labour force have different characteristics (e.g. degree of attachment to the labour force) that cause their equilibrium rates to differ permanently, or in "change" form, where the aggregate NAIRU changes only temporarily (e.g. while new entrants acquire job skills).

Some economists argue that the extent of unionization is an important determinant of the equilibrium unemployment rate. They maintain that if unions can successfully raise and hold the real wage above the solution under perfect competition, the economy may find an equilibrium with higher capitalization and more unemployment. In this case the displaced workers are involuntarily unemployed, but the market cannot absorb them at the high fixed wage.

Another common argument is that the NAIRU may rise temporarily in an economy undergoing structural change. The traditional notion of "structural" unemployment refers to the result of changes in the mix of activities. This could arise from a change in technology or in the composition of demand, a change in the competitiveness of a domestic industry in world

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2 Some supporters of the Unemployment Insurance program hoped that it would raise efficiency by giving workers the chance to find a job that better matched their tastes, thus reducing the turnover rate and the NAIRU. While this may have been the case for some workers, it does not appear to have been the case as a general rule.

markets, resource discovery or depletion, etc. When relative prices change and resources must be reallocated, there may be a period of structural unemployment. Workers may have to learn new skills or relocate to other centres of their traditional employment. This would increase the NAIRU during the adjustment period.

In addition, relative price changes can be misinterpreted as changes in inflation, especially if prices are slow to adjust to shocks. There may be no change in the long-run equilibrium rate of unemployment, but in the short run the NAIRU may be affected as a result of changes in inflation expectations. If there are productivity shocks that are not fully understood, the same thing may happen because of errors in perception of the market-clearing real wage. Indirect tax changes can have a similar effect, if workers attempt to insulate their private purchasing power from such changes.[3]

An idea that has gained considerable support, especially with respect to the situation in Europe, is that there is no equilibrium unemployment rate in the traditional sense. Rather, it is argued, the data are better described as a random walk. This "hysteresis" view, that the path of the unemployment rate influences its ultimate equilibrium level, either because unemployed workers lose skills and become less employable, or because institutions function to block labour market adjustment (e.g. insiders protect high wages -- often linked to the "unions" story), has been less convincing empirically when applied to North American data. Nevertheless, economists have not been able to provide a convincing explanation as to why the Canadian unemployment rate has remained high in recent years, relative to that of the United States, and further work on this issue may uncover some "hysteresis" effects.

3.2 Variables related to Unemployment Insurance (UI)

Recent history of the Canadian UI program

The Canadian UI program has been changed several times, most notably in 1971, when coverage and basic benefits were increased substantially and "labour force" and "regionally extended" benefits were introduced. Since 1971, reforms have generally tended to tighten the rules, although the application of regional benefits has become somewhat more generous. In 1976

3 There is also an arithmetic argument. When relative prices are changing because of indirect taxes or whatever, the measured rate of inflation will generally change, temporarily. If the NAIRU is taken to mean literally the no-change-in-inflation rate of unemployment, then it will change from period to period with the shocks. It is the more systematic effects through errors in interpreting shocks that concern us here.

the benefit rate[4] for claimants with dependents was reduced from 75 per cent to 66.7 per cent, and the disqualification period (applied to those who had quit voluntarily, for example) was raised from 3 to 6 weeks. In 1977 the minimum work period needed to qualify for benefits was raised from 8 weeks to a variable period of between 10 and 14 weeks. However, the maximum regional-benefit period was increased from 18 to 32 weeks and the calculation of actual benefits was made somewhat more generous. In 1979 the benefit rate was further reduced to 60 per cent, and a repayment provision was introduced to limit the benefits retained by claimants who subsequently earned high incomes. Also, the qualifications for labour market re-entrants were tightened.

The economic effects of UI

The Macdonald Commission (see the background paper, Cousineau 1986, for example), the Forget Commission (1986), the Royal Commission on Employment and Unemployment in Newfoundland (1986), the Federal-Provincial Task Force on Regional Development (1987), and a host of academic studies[5] have argued that UI increases equilibrium unemployment. The following reasons can be identified: (i) the costs of employment separation and job search are reduced, causing more frictional unemployment; (ii) workers (with tacit consent of firms) exploit the UI program by cycling their employment spells to qualify for benefits, effectively subsidizing leisure and raising the NAIRU; (iii) people who would otherwise not be in the labour force are induced to work to qualify for benefits as in (ii); (iv) industries with cyclical or seasonal employment are subsidized and therefore attain a higher share of employment than they otherwise would, causing higher average unemployment;[6] (v) in Canada, the regional differentiation of benefit entitlement may further reduce labour mobility and institutionalize pockets of high unemployment.

Measures of UI disincentive signals

The maximum UI benefit, scaled by the average industrial wage (Chart 1), shows part of the opportunity cost of working (i.e. foregone UI payments). Before the 1971 reforms, the UI benefit rate was neither indexed nor systematically adjusted to reflect productivity gains. The ratio therefore tended

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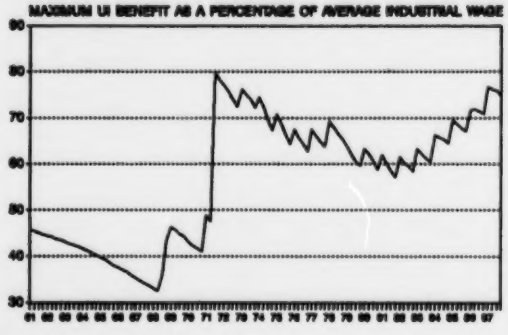
4 The benefit rate is the income replacement rate under the UI program. A qualified unemployed person will receive the benefit rate times the insured earnings rate. There is a maximum insurable earnings.

5 We describe below some work on UI in particular. In an important study, Fortin and Rousseau (1984) show that the combined effects of taxation and social support programs generate important disincentives to labour supply and raise the equilibrium unemployment rate.

6 This is partly avoided in the United States by "experience rating," wherein unemployment in high turnover activities is treated less generously or is insured at higher contribution rates.

CHART 1

MAXIMUM UI BENEFIT AS A PERCENTAGE OF AVERAGE INDUSTRIAL WAGE

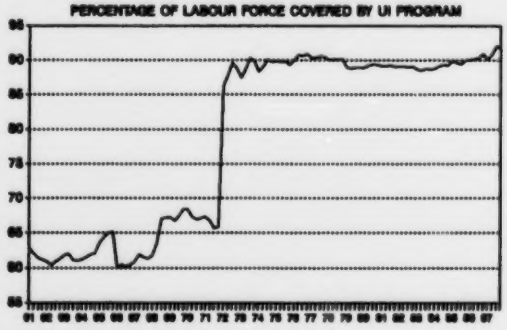


to drift downward over time until specific attention was given to the benefit level (e.g. 1968). The level was dramatically increased in 1971 and linked to an 8-year moving average of market wages (the sawtooth pattern shown in Chart 1 reflects the regular adjustment). Because of the lags in the automatic adjustment, the acceleration of inflation caused the benefit/wage ratio to resume its downward trend. Since 1982, however, the effects of the high inflation years have been captured in the benefit rate and the ratio has almost regained its 1971 level. Although not every unemployed person is eligible for the maximum benefit, this measure shows that the potential disincentive from UI has risen somewhat during the 1980s.

The proportion of the labour force covered by UI rose in 1971 from just over 60 per cent to about 90 per cent. It has been roughly constant since then (Chart 2).

CHART 2

PERCENTAGE OF LABOUR FORCE COVERED BY UI PROGRAM



These measures ignore important features of the complex UI program. In particular, regionally extended benefits depend on regional unemployment rates. Although unemployment has risen in all regions since 1971 (when the benefits were introduced), the increase has been particularly marked in the Atlantic provinces, where regional benefit payments have been important.[7] Some regions of Canada may be in a high-unemployment trap, as generous regional benefits undermine the work incentive and raise the cost (in terms of foregone potential UI benefits) of moving to regions where unemployment rates are lower.

7 In 1986, for example, the proportion of UI benefits derived from the regional part of the program was 37.4 per cent for the four Atlantic provinces, compared with 25.2 per cent for the country as a whole (all provinces had areas eligible for regionally extended benefits).

The disincentive from the regional benefit may be particularly important because it offers payments not tied to the duration of past employment.

Empirical measures of the effects of UI on the NAIRU

Economists have devoted considerable effort to measuring the effect of the 1971 UI reforms on the NAIRU. Estimates range up to about 2 percentage points; RDXF, the Bank of Canada's quarterly econometric model (Robertson and McDougall 1982), embodies an effect of about 1.75 percentage points. A summary of the literature (including U.S. evidence on UI effects) is available in Cousineau (1986).

Recent work using Canadian weekly microeconomic data (Ham and Rae 1987) provides estimates of the marginal effects of various aspects of UI. For example, they estimate that an increase of 1 week in the entitlement raises the expected duration of unemployment by 0.33 weeks. This implies an increase in the unemployment rate of about 3.6 per cent using the sample average duration (9.2 weeks), or about 0.3 percentage points at an initial unemployment rate of 8.5 per cent.[8]

Recent U.S. work also confirms an important disincentive effect (Kingston et al. 1986, St. Louis et al. 1986). In a particularly revealing study, Woodbury and Spiegelman (1987) describe a controlled experiment conducted in Illinois where a sample of eligible UI claimants were offered a $500 cash payment if they got a job in under 11 weeks and held it for a minimum of 4 months. The results showed a dramatic decline in the average duration of unemployment (and many successful seekers did not bother to claim the bonus once they were working). This study shows that the level of the dollar incentives on the margin can have an important effect on search and employment decisions.[9] The authors conclude that there is clear evidence in their results that UI has disincentive effects by subsidizing leisure.

Conclusions on UI

The evidence that UI has a significant effect on the NAIRU is convincing. This evidence comes in many forms, ranging from detailed microeconomic

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8 If this marginal effect had applied to the entire increase in the maximum regional-benefit period introduced in 1977 (14 weeks), unemployment would have risen by about 50 per cent. This obviously overstates the effect, because the benefit is not generally available, and where it is available the maximum is often well above the actual entitlement. Nevertheless, it is clear that the extension of regional benefits could explain a significant portion of the general increase in unemployment from before the recession to the recovery period after the recession.

9 Unfortunately, Ham and Rae claim to have been unable to estimate a benefit-rate effect for Canada because of lack of rate variation in their sample (1974-80). They seem to have limited their thinking to the nominal, absolute benefit rate. It seems to us that there is enough variation in the relative-to-wage benefit rate to have made the exercise interesting.

studies of the behaviour of recipients of UI to estimates from broad macroeconomic equations. That UI variables do not always enter statistically significantly in estimations of macroeconomic relationships does not alter the balanced conclusion one would draw from the available evidence. Estimates indicate that the 1971 UI reforms increased the NAIRU by up to 2 percentage points. Since then the UI program has been tightened up in some respects, but expanded regional benefits and a rising maximum UI benefit relative to the average industrial wage in the 1980s have been working in the opposite direction. Little direct quantitative evidence is available on the impact of the regional benefits on the NAIRU, but the observations of the Newfoundland Royal Commission, for example, lend support to the view that this aspect of UI has increased the average level of unemployment.

3.3 Demographic variables

In an economy with a stable population structure and a labour force growing at a fixed rate, the special characteristics of segments of the labour force may be of little importance in macroeconomic analysis generally and in discussions of the NAIRU in particular. However, if there is a major change in the growth or demographic composition of the labour force, the details may be important in the determination of the aggregate NAIRU.

Higher labour-force growth with sticky wages

In this case there need not be a structural demographic change. For example, consider a higher level of immigration that preserves the age-gender structure of the labour force but raises its growth rate. The concern that immigration might crowd out existing workers from a limited number of jobs is based on a view that aggregate demand would not adjust rapidly enough to provide immediate employment for the new workers. Of course, this would not create unemployment if the wage were sufficiently flexible to provide short-term market clearing, but if some wage rigidity is assumed there could be higher unemployment while demand adjusts to the new level of potential output.[10]

Young workers

The movement of the "baby boomers" into the labour force has the pure growth effect, but adds to it the demographic effect of a change in the age structure of the labour force. Two kinds of explanation have been given as to why this might have caused the NAIRU to rise. The first is the pure transition argument – that the economy has had trouble absorbing the bubble of

10 Nothing in this discussion should be taken to imply endorsement of a particular view of the short-term consequences of a change in immigration. The discussion is intended solely to establish a contrast between possible effects from a pure level shock to labour supply and a shock with composition effects.

labour and that it has nothing to do with youth or the characteristics of this particular cohort. This effect would be transitory. The second type of argument focusses on the demographic aspect of the phenomenon. There are many variants. Some focus on youth, per se, and argue that whether because of real differences (e.g. lack of skills, weak attachment to particular jobs associated with a youthful desire to try different things) or perceptions (e.g. subjective evaluations of appearance), youth unemployment is higher than adult unemployment. Therefore, when a bubble passes into the labour force there will be a rise in the aggregate NAIRU simply because there is more of the segment with a high rate. This, too, leads to the prediction that the effect will be transitory. It is youth, per se, not the size of the cohort, that matters. As the cohort ages, the temporary youth effect on unemployment will disappear.

Other explanations focus on the cohort. An extreme example is the case of fixed-proportion (Leontiev) production, with each type of labour treated as a different factor. The job prospects of each group are then limited by the slowest-growing component. In this case, a cohort that is unusually large will face a lifetime of above-average unemployment. The same result arises if there is a hysteresis effect (e.g. unemployment erodes human capital or otherwise changes employability).

Young workers (15 to 24 years of age) do have a rate of unemployment that is consistently and significantly above the average (See Chart 5, page 13). Moreover, from the early 1960s to the mid-1970s, this group's share in the total labour force rose from under 22 per cent to over 27 per cent. Since then, the share has declined to under 21 per cent (Chart 3).

CHART 3
YOUTH SHARE OF LABOUR FORCE

Assuming that the changing youth share has influenced neither youth nor adult unemployment rates, the pure composition effect cannot explain much of the variation in aggregate unemployment. A fixed-weight index of unemployment suggests that the youth effect was about one-quarter of one percentage point during the mid-1970s. Even under extreme assumptions about the weights and the difference between adult and youth unemployment rates, less than one-half of a percentage point increase in the unemployment rate during the 1970s can be attributed to the purely arithmetic effect of a higher

youth share.[11] The assumptions are important, however. If any of the upward drift during the 1970s in the specific adult or youth unemployment rates is attributable to the rising youth share, then these calculations are incomplete.

Youth unemployment rose more than proportionately during the 1981-82 recession and has since fallen more than proportionately. The pure effect of the changing share is hard to separate from the effect of the recession and recovery. In our judgment, however, although changes in the youth share have affected the youth unemployment rate, this effect is not large enough to explain much of the rise and subsequent fall in the aggregate unemployment rate.

Female workers

Another important phenomenon in Canadian labour markets has been the steady rise in the female participation rate. The share of women in the labour force has risen steadily from under 24 per cent in the early 1950s to nearly 44 per cent today (Chart 4). This phenomenon has also been cited as a possible cause of the upward drift in the aggregate unemployment rate. As in the consideration of youth effects, there are many variants to the argument.

The rising female participation has been an important source of growth in the labour force. Also, one could argue that while it was known in advance that the youth bubble was going to pass into the labour force, the sharp increase in female participation was not anticipated fully and therefore caused a general absorption problem.[12]

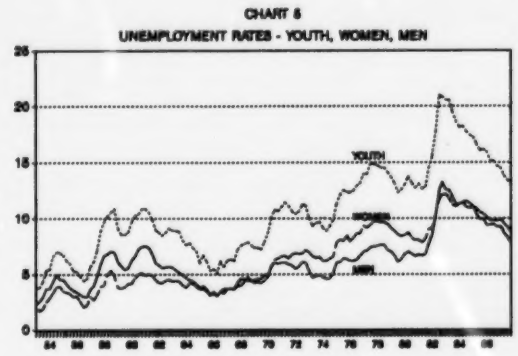
CHART 4
FEMALE SHARE OF LABOUR FORCE

The argument for a simple composition effect (i.e. that the unemployment rate is higher because the share of women is now higher) appears to be on much weaker ground than the parallel argument for young

11 This is consistent with estimates presented by Reid and Smith (1981).

12 Recent work on this issue using U.S. data (Spector 1988) supports this interpretation. Spector concludes that rising female participation has raised the NAIRU, but from the growth itself not from the fact that the growth is heavily weighted towards women.

workers. The unemployment rate of women has not been very different, on average, from the rate for men (Chart 5). There has, however, been an important difference in the trends, with the female rate tracking below the male rate until the mid-1960s, and then above it through the 1970s. If we treat the 1970s as a separate sample, the unemployment rate gap between men and women does seem big enough to be structurally significant, given the quite dramatic rise in the female participation rate. However, the purely arithmetic effect of the higher female share (i.e., the change in the aggregate rate of unemployment if we recompute it assuming a constant female share) is less than 0.3 percentage points.



The above calculation ignores the possibility that the rise in the female rate of unemployment may have been itself caused by the rising female participation. It has been argued that in the past women have had a lower attachment to the labour force, have been more inclined to leave the labour force to suit their spouses' careers, and so on, and may have had a lower equilibrium rate of unemployment as a result. These things are changing. Also UI may have drawn more women into the labour force who do not expect to work full time. These arguments both say that women have become more like men with respect to their labour force behaviour, and that this has increased their equilibirum unemployment rate. Some of these effects of a rising female share are likely transitory (e.g. the result of lack of job experience).[13] Indeed, during the 1980s the gap between female and male unemployment rates has narrowed again.

The increase in the female unemployment rate relative to the average during the 1970s is not large enough to establish a clear case that rising female participation has been an important cause of the general rise in the unemployment rate. Assuming that more female employment does not cause higher male unemployment, the extra effect of the rise in female unemployment since the early 1970s (when the male and female rates were equal) is less than

13 It is noteworthy that the increase in female participation is not limited to young women. Many older women have returned to the labour force or joined it for the first time. This group is different from men of similar age in terms of human capital and work experience.

1 percentage point. The effect of the rising share, combined with the rising unemployment rate for women, accounts for less than 1.25 percentage points in the overall rate. This is not trivial, but neither does it explain the bulk of the increase.[14]

Factor-substitution and wage-adjustment issues

At several points in the discussion of youth and gender effects, the argument has been qualified with an assumption that the changing demographics have not influenced the adult or the male unemployment rate. Various views have been expressed on possible interaction effects, based on different assumptions about the substitutability of the various types of labour in production and the degree of wage flexibility. If labour is homogeneous, but wages are sticky, any supply bubble may result in higher unemployment in the short run. If the various types of labour are not at all substitutable, the cohort effect noted in the discussion of youth may arise (for women as well).[15] In the intermediate case of less-than-perfect substitutability, a variety of circumstances can be imagined. One argument is that the problem is rigidity of the relative wage – that women are not perfect substitutes for men (possibly a temporary effect) in production, and that the regulatory environment has prevented the female wage from falling relative to the male wage. In this case, the rise in overall unemployment is the result of a higher female unemployment rate. This argument emphasizes the differences between types of labour. An alternative is to think of the problem as competition between labour types that are almost the same. In this case the growth in youth or female supply could cause a substitution away from higher-priced adult men and a rise in their unemployment rate in the adjustment period. A system of seniority or any type of sinecure that prevented a fall in male wages would increase the adjustment problem.

Evidence from estimation

In econometric estimates (of a Phillips curve or Okun's Law equation) the female labour force share is usually significant. This effect is difficult to distinguish from a pure time trend, however, and it is hazardous to draw causality conclusions. As noted above, we are convinced that UI has had an important effect on the NAIRU, but because the UI variables are dominated by the large step in 1971, they tend to be statistically insignificant in explaining the more smoothly trending unemployment rate if any competing

14 This calculation ignores the possibility that part of the rising male rate of unemployment may have been caused by competition from women. This could be because the male wage was too high and sticky in the face of the competition, or simply because aggregate demand lagged the growth in potential.

15 A related argument is that firms in different sectors tend to employ men and women in different proportions. Thus, when one type of activity prospers relative to others there can be changes in the equilibrium rate of unemployment by gender, at least temporarily.

measure, such as the female participation rate or labour force share, has a trend component.

The youth share tended to be significant in econometric exercises until it began to decline sharply in the 1980s, when its estimated influence switched sign. The cut-off of "youth" at age 24 is somewhat arbitrary. It may be necessary to recognize a more gradual transition between youthful and adult working years in order to capture empirically the effect of the entry of the "baby boom" generation into the labour market.

Conclusions on demographics

It is our conclusion that the bulge in youthful workers raised the NAIRU somewhat in the early and mid-1970s. Since then, this effect has been reversed and will continue to provide some downward movement in the NAIRU over the next few years. Similarly, we conclude that the increase in female participation has contributed to an increased NAIRU and that this has been more important than the youth effect. However, the female participation rate is beginning to stabilize. To the extent that higher unemployment was caused by changes in female participation as opposed to a higher level of participation, the equilibrium unemployment rate for women should begin to decline. Moreover, we expect that as the older women who have entered the labour force begin to retire, as the human capital of all new entrants rises, and as the younger new entrants proceed into their adult working years, the male-female differential will be largely eliminated and the overall NAIRU will decline from current levels.

3.4 Regional/industrial dispersion and relative price changes

Economic shocks that require reallocation of labour may imply a temporary increase in structural unemployment. This suggests that the observed increase in the differences in regional unemployment rates in the 1980s, in part attributable to relative (commodity) price declines, may have contributed to a temporary increase in the NAIRU. If the variability of such influences has increased, there may be a permanent component to the increase in the NAIRU.

Econometric evidence is mixed. The original Lilien (1982) and Samson (1985) studies indicated a strong effect of dispersion measures, but this seems to be largely due to use of monetary surprises as their sole business cycle indicator. Dispersion measures proved insignificant in the Okun's Law type of estimations discussed below. Similarly, a dispersion measure was found insignificant by McCallum (1987) in an unemployment equation, although he did find small but statistically significant effects from specific measures of structural shocks such as changes of relative export prices. In the RDXF Phillips curve, the variance of unemployment rates across provinces would

enter negatively; that is, increased variance would lower the NAIRU, contrary to the dispersion hypothesis. Attempts to fit regional Phillips curves proved inconclusive on this issue, but provided some support for the view that conditions in tight markets can spill over to other areas.

Despite somewhat weak evidence, we think that this type of effect is important. Many activities in the Canadian economy are associated with specific resources in specific locations. When prices change, labour market adjustment is difficult because it involves physical as well as sectoral relocation. Thus, we think that the NAIRU does rise for some time following sharp movements in relative prices. This is likely to be particularly important when an older, established labour force is affected.

3.5 Sectoral shocks and unions

The classical explanation of why an economy might suffer a bout of unemployment was that real wages could get too high. A modern variant of that view has emerged which associates increases in the NAIRU with high real wages generated and protected by unions.

Work by Summers (1986) supports this argument for the United States. From 1985 cross-section data by state, Summers estimates that a 10 per cent increase in a state's unionization rate causes a 1.2 percentage point increase in equilibrium unemployment. This effect was statistically significant and capable of explaining a sizable part of the variation in unemployment by state. Summers also compares data for 1970 and 1985 to see whether the effect of unions on unemployment has changed over time. He finds that a state with an average unionization rate had an increase in unemployment, relative to a hypothetical no-union state, of 1.2 percentage points. That is, the impact of unions on unemployment has risen.[16] This is only partly offset by the fall in the overall rate of unionization. He concludes that a significant part of the increase in unemployment in the United States in the 1970s can be attributed to the effects of unions.

Daly and MacCharles (1986) and Grubel and Bonnici (1986) have made the case for Canada. Their argument is that for a variety of reasons, including temporarily favorable price shocks mistakenly expected to be permanent, the unionized sector (of resource industries in particular) was able to capture unwarranted real-wage gains that were not quickly reversed when prices softened. The result, particularly after the 1981-82 recession, was a loss of jobs and an attempt to stay competitive through increased use of

16 Summers also reports evidence that the union wage premium increased over the 1970s and has declined slightly in the 1980s, although by less than suggested by macroeconomic indicators such as the employment cost index.

capital. These authors believe that unions can significantly increase the equilibrium rate of unemployment by pushing the real wage above its competitive level. Moreover, if the loss of domestic cost competitiveness triggers real exchange-rate depreciation, this would help protect the high-wage sectors (generally traded goods) and pass some of the costs to other sectors (generally non-traded goods) and to other workers. A depreciation would shelter the unionized sectors from the competitive consequences of higher domestic costs, and (by raising import prices) would increase costs in other sectors and lower real wages from a consumption perspective, especially for those (non-unionized) workers who had not shared in the original nominal wage increases.

4. THE PHILLIPS CURVE AND OKUN'S LAW

The degree of slack in labour markets -- the difference between the actual and the equilibrium rate of unemployment -- is important information for policy makers. However, there is a great deal of uncertainty surrounding its measurement. This uncertainty stems from the fact that the equilibrium rate cannot be observed and must be inferred from other data using presumed and uncertain economic relationships. Two of these relationships are the *Phillips curve* and *Okun's Law.*

The expectations-augmented Phillips curve can be written as:

$$\dot{w} = \pi + g - \delta(u - u^*) + \chi\beta + \varepsilon \qquad (1)$$

where
- $\dot{w}$ represents nominal wage growth,
- π is expected inflation,
- g is expected productivity (and warranted, i.e. equilibrium, real wage) growth,
- u is the measured unemployment rate,
- u^* is the NAIRU,
- χ is a set of other influences on wage growth (such as influences of incomes policies, relative price changes, etc.), with coefficients β, and
- ε is a random variable.

The appeal of using an estimated Phillips curve to measure the equilibrium rate of unemployment lies in the presumption that there will be a close relationship between wage movements and labour market disequilibrium. However, expected inflation and warranted real wage growth are also unobserved, and must also be approximated using indirect measures. Errors in these measures can significantly bias an inferred NAIRU. Moreover, unless the NAIRU is assumed to be constant through time, its determinants must be specified before equation (1) can be estimated.

The Phillips curve has dominated discussions of macroeconomic adjustment for almost three decades. Yet for some economists it "still lacks convincing theoretical foundations" (Blanchard 1987). As normally used in macro models, the Phillips curve is associated with the idea that macroeconomic adjustment is slow, and especially with the idea that real disequilibrium is *necessary* for nominal adjustment. This, too, is being challenged in the literature, both theoretically and empirically (e.g. Summers 1987). Nevertheless, many economists still find the Phillips curve a useful concept for understanding wage and price dynamics. It remains an important part of Bank of

Canada models of macroeconomic adjustment. But this does not mean that we can claim high explanatory power or temporal stability for the empirical relationship. Therefore, there is considerable uncertainty surrounding any estimates of the NAIRU derived from a Phillips curve for Canada.

Okun's Law posits a simple, direct relationship between the output market gap and the labour market gap:

$$u - u^* = \Theta (y^* - y) + v \qquad (2)$$

where y^* is the log of potential output,
y is the log of actual output,
Θ is the coefficient linking the gaps and
v is a random variable.

Okun's (1962) Law was presented originally as an empirical regularity. The appeal of using it to infer the NAIRU arises from the fairly robust nature of this regularity over time and in different countries, as well as from the fact that the NAIRU is a real variable and might best be observed from data on the real performance, as opposed to the nominal dynamics, of the economy. Okun's Law applies where output is essentially demand-determined and employment is the main variable firms use to adjust production to demand over the business cycle. If this paradigm is reasonable, one could infer the NAIRU from equation (2), given a measure of the output gap and a value for Θ. This would not deny the validity of the Phillips curve, but it might provide a better measure of u^* if we could identify more readily the output gap than the necessary inputs for equation (1). However, if output fluctuations are associated with the intensity of the use of capital, or movements in labour productivity, hours, or some other variable factor, then Okun's Law will not have much explanatory power and will be of little use as a means of measuring the labour gap.[17]

To estimate the NAIRU from either (1) or (2), the relevant parameters must also be known. To estimate the parameters, either data or functions of data must be provided for all variables. For the Phillips curve, in addition to providing measures or functions for productivity and expectations and to deciding on the special factors (χ variables), some basic assumptions about the NAIRU must be added (in order to specify the labour market gap). The simplest examples are the assumption that it is a constant or a step function, with shifts occurring at times of significant institutional change (e.g. in

17 This could also happen if firms used inventories to buffer demand shocks to the extent that there was little variation in the output or labour gaps.

unemployment insurance). In general, however, one must allow for a variety of influences on the NAIRU:

$$u^* = f(Z, \phi) \qquad (3)$$

where Z is a set of explanatory variables and
ϕ is a set of coefficients.

To estimate the Okun's Law parameter, one needs either an output gap measure or a model for potential output, as well as some hypothesis about the determinants of the NAIRU (i.e. a particular version of equation (3)). A weakness in simple implementations of Okun's Law has been the tendency to ignore the modelling aspects of the problem and to assume that output and unemployment are equal, on average over the sample, to their potential and equilibrium equivalents. A simple trend through actual output has often been used as a proxy for potential output.[18] This approach may provide consistent estimates in large samples and can be justified in small samples under the assumption of strong tendency towards equilibrium. There could, however, be serious biases with the small samples typically available, especially if inflation has accelerated or decelerated over the period, since this may mean that output has not been at potential on average in the sample. This is particularly worrisome for the 1970s and 1980s, where one also has to deal with energy price shocks and apparent changes in trend productivity.

Okun's Law is formulated with unemployment as the dependent variable, yet there is an obvious possible problem in estimation coming from the simultaneity of output and employment. One approach that has been widely used is a reduced-form unemployment equation (e.g. Lilien 1982 and Samson 1985). These authors have suggested that the regional or industrial disperson of employment growth (caused by relative price shocks, for example) can explain the increase in unemployment as a structural phenomenon. Recently, McCallum (1987) has taken the reduced-form approach, extending the Lilien-Samson model to see whether specific measures of sectoral shocks, as opposed to dispersion in employment growth, per se, can explain any of the increase in Canadian unemployment.

A theoretically preferred, but more ambitious, approach is to add a model of potential output to Okun's relationship. This would normally involve a production function and would allow the capital stock, trend productivity,

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18 Another common approach has been to estimate the Okun's Law equation in first-difference form, based on the (usually implicit) assumptions that the NAIRU is constant and that potential output grows at a constant rate.

the trend labour force (i.e. including effects of changes in the trend participation rate), and the NAIRU itself to affect the implicit measure of potential:

$$y^* = F(K, (1-u^*) \cdot L \cdot e^{gt}) \qquad (4)$$

where K is the stock of capital,
L is the trend labour force, so $(1-u^*) \cdot L$ represents fully employed labour and
g is the trend rate of productivity growth, in terms of labour-embodied technical progress.

Estimating equations (2), (3) and (4) simultaneously brings extra information to bear on both the appropriate specification and the magnitude of the NAIRU, relative to the simplest Okun's Law approach. Including the Phillips curve in the system offers further potential identifying power by exploiting the nominal dimension of the effect of u^* and the productivity restriction (g appears in both (1) and (4)).

This system approach attempts to identify the NAIRU by focussing on the real economy plus wage adjustment. An alternative system approach, which has been adopted by Pierre Fortin and others, uses the system of wage and price dynamics. Fortin (1986) substitutes the wage equation into a price equation to obtain a "price" Phillips curve, but the underlying wage-price system could be considered directly. This maintains the focus on the nominal adjustment process as a way to infer the NAIRU, but uses more than the information on wages in the estimation.

In the sections that follow we report estimates of the NAIRU derived from all these approaches.

5. THE RDXF PHILLIPS CURVE

5.1 Structure

The RDXF Phillips curve has the structure of equation (1), repeated here for convenience:

$$\dot{w} = \pi + g - \delta (u - u^*) + \chi\beta + \varepsilon \qquad (1)$$

The equation is estimated using quarterly data. The quarterly wage growth variable is derived from average weekly earnings data for the commercial sector, from Statistics Canada's Survey of Employment, Payroll, and Hours (SEPH), or from its predecessor. We specify that it is an hourly wage that is determined, and add an hours trend to the equation, with an imposed unit coefficient to respect the marginal product condition in terms of hours.[19]

The trend of total factor productivity (TFP) is calculated from the RDXF, private-sector production function.[20] The residual from the function fitted to actual output is assumed to reflect only movements in total factor productivity; possible problems of specification or measurement are ignored. The residual series is smoothed by judgmentally imposing time trends and by using long, moving-average filters. The smoothed series provides our estimate of trend factor productivity (ETFP), from which we derive the "g" of equation (1).

Expected inflation, π, is modelled as an eight-quarter moving average of the growth rate of the consumer price index (CPI).

The only other variables in the current equation are the growth rate of the relative price of private production to consumption, and a dummy for the Anti-Inflation Board (AIB) period (1975Q4 to 1978Q3).

The current RDXF model does not attempt to describe the historical evolution of the NAIRU, except for the shift associated with the 1971 UI reforms. We estimate, from work using the Okun's Law equation, that these reforms added about 1.8 per cent to the equilibrium unemployment rate. This shift is imposed in the Phillips curve, but the otherwise-constant level of the NAIRU is freely estimated. Note that equation (1) has no extra constant. All

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19 This ignores complications such as how overtime and part-time work influence aggregate average hourly earnings.

20 See Robertson and McDougall (1982) for a description of the traditional methodology. Recently, we have begun to calculate productivity trends using the techniques suggested by Prescott (1986).

χ variables are special factors that have no long-run effect on wage growth (e.g. the AIB dummy). The estimated constant (adjusted for the UI shift dummy) is interpreted as δu^*.

5.2 Brief history

Since 1981 the structure of the Phillips curve has remained essentially as described above. However, prior to the spring 1985 version of RDXF, the NAIRU was imposed on the Phillips curve, based on work using an Okun's Law approach, and no free constant was allowed. Another exception is the coefficient on trend total factor productivity, which has at different times been set to one or freely estimated, and is now imposed at 1.6 (the inverse of labour's production function coefficient; see Pelletier (1988) for a description of the source of this restriction).

There have been several important changes in our measures of the variables, however, due to changes in our definitions as well as revisions of the basic source data. For example, calculations of trend factor productivity have changed substantially over time, due to redefinitions of "private sector" output and changes in judgment as to the trend. Also, in 1985 the wage variable was redefined. Earlier, it had been calculated as labour income per worker (using employment from the survey of establishments), a procedure that built all employment and labour-income measurement errors into the wage series. Since 1985, the wage measure from the establishment survey has been used directly.

Changes in sample period, coupled with these data changes, have led to substantial variations in the parameter estimates. For example, the coefficient on the labour market gap has varied between 0.24 and 0.09, and has sometimes been statistically insignificant. The coefficient on the relative producer price has varied between 0.57 and 0.26.

5.3 Properties of the current model

A one-percentage-point increase in the unemployment rate reduces wage growth by 0.36 percentage points per year. The equation is accelerationist in that expected inflation has a unit coefficient, so that a shift in the actual inflation rate passes through one-for-one (with lags) to wage growth, and unemployment cannot be held permanently below the NAIRU without generating accelerating inflation.[21]

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21 The accelerationist result cannot be deduced from the wage equation alone. This analysis assumes the rest of RDXF and the standard mark-up model of price determination in particular.

A one percentage point increase in the relative producer price increases the level of wages by 0.6 percentage points over 7 quarters.

The Anti-Inflation Board dummy indicates that while the AIB program was operating, it reduced annual nominal wage growth by about 1.8 percentage points, ignoring feedback effects.

5.4 The NAIRU from the RDXF Phillips curve

The NAIRU for recent years implied by the estimated RDXF Phillips curve is 10.4 per cent.[22] An approximate 95 per cent confidence interval for this estimate is 2.5 percentage points, i.e. 7.9 - 12.9 per cent. We do not believe, however, that the natural rate is as high as 10 per cent. Other evidence generally supports a lower value. In section 7 we attempt to explain why the RDXF results tend to be higher than those obtained by other researchers. An obvious question, however, is whether the estimate could be too high because of misspecification elsewhere in the equation. The next sub-section examines the sensitivity of the NAIRU estimate to the way productivity growth and inflation expectations are specified.

5.5 Sensitivity of the RDXF NAIRU estimates to the modelling of productivity and inflation expectations

Productivity

An assumed increase in the average growth rate of trend productivity would, all else being equal, reduce the estimated constant in the Phillips curve (and hence the implied NAIRU). However, given the estimated gap coefficient, to lower the measured NAIRU by one percentage point would require an increase in the annual rate of productivity growth of about 0.3 percentage points. To lower the NAIRU estimate to 7 per cent, all else being equal, trend productivity growth would have to be more than double the sample average of measured total factor productivity growth. In other words, the constant is large, and it is not possible to explain away much of it as bias in the average level of estimated productivity growth, unless we change some other part of the model dramatically (e.g. the production function).[23]

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22 Although formally this estimate applies to the entire period after the 1971 UI reforms, we do not consider it pertinent for the early part of this period.

23 The RDXF methodology presumes that the portion of actual output that is not explained by the production function is an observation on total factor productivity. Any specification error or mismeasurement of these variables shows up in TFP and possibly in the trend used in the Phillips curve.

The above discussion is based on the RDXF measure of trend total factor productivity growth. Over the historical sample, the actual increase in output per person-hour has been higher than the increase in the RDXF measure of productivity, because of an increasing capital/output ratio. The RDXF Phillips curve uses the trend total productivity growth measure (adjusted to labour-embodied units as noted above) for warranted real wage growth and ignores level adjustments associated with changes in the capital/output ratio. If the alternative productivity growth measure, based on the ex post average product of labour (APL), is used in place of the RDXF measure in the regression, the Phillips curve results are quite poor in terms of fit and in terms of equation properties (e.g. the productivity term is not significantly different from zero).

A change in the *pattern* of productivity growth, as opposed to its average rate, could also have an important effect on the estimated NAIRU by altering the estimated gap coefficient. For example, if the RDXF Phillips curve is estimated assuming a constant rate of productivity growth (calculated as the sample mean of TFP growth) we get a NAIRU 1.3 percentage points lower than with the usual ETFP measure (i.e. 9.1 instead of 10.4 per cent). If the same experiment is performed with the mean of the APL productivity measure described in the previous paragraph, the resulting estimate is considerably lower, about 7.7 per cent.

Inflation expectations

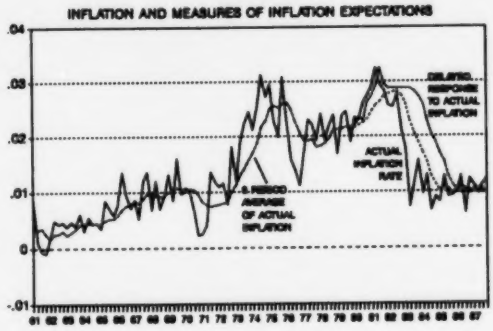
If measured inflation expectations were too low, on average, there would be a tendency to overestimate the NAIRU. It is difficult to assess the accuracy of models of expectations of inflation, since there are no direct measures. A criterion that is often used, based on the argument that expectations will not be systematically biased, is the extent of forecasting error implied by the measure of expectations. The average error in RDXF's inflation expectations measure is small, so there is no simple case for bias of this sort. However, if we allow that expectations could, in fact, have differed systematically from actual inflation over the sample, there could still be bias. The argument that expectations will not be systematically incorrect applies in large samples or cases where the environment is stable. The run-up in inflation in the 1970s and the subsequent period of disinflation does not represent such a stable environment. It is also important to note that the pattern of expectations errors can affect the estimated unemployment gap coefficient, and hence the implied NAIRU, whether or not there is average error in the expectations and bias in the estimated Phillips curve constant.

The results seem very sensitive to the specification. For example, if ARIMA forecasts are used as inflation expectations (see the discussion of Riddell and

Smith, below), the RDXF Phillips curve degenerates. We get the wrong sign on the gap coefficient and cannot estimate the NAIRU. However, if we impose a less responsive expectations structure beginning just before the 1981-82 recession, so that expected inflation stays high longer and comes down more slowly (Chart 6, delayed response to actual inflation), we get a higher gap coefficient and an estimate of the current NAIRU of 8.4 per cent, a full 2 percentage points below the RDXF estimate.

CHART 6

INFLATION AND MEASURES OF INFLATION EXPECTATIONS



6. SYSTEMS ESTIMATES OF THE NAIRU BASED ON OKUN'S LAW

6.1 Past estimates - standard Okun's Law

Estimates of the NAIRU based on Okun's Law, produced at the Bank of Canada and elsewhere, have typically represented potential output using a time trend, sometimes augmented by a productivity growth term. These estimates are broadly similar, suggesting a NAIRU rising from 4-5 per cent in the 1960s through 7 per cent in the mid-1970s and reaching 9 per cent by 1983. See, for example, Aubry et al. (1979,1983).

6.2 System approach

The Laxton model

We have extended past work by estimating an Okun's Law relationship simultaneously with a production function and the Phillips curve, in an effort to bring extra information to bear on both the appropriate specification and the magnitude of the NAIRU.

The traditional implementation of Okun's Law relies on a time-trend specification of potential output. Although straightforward, this approach has several disadvantages. First, the use of a regressed time trend to model potential tends to force the output gap (and, therefore, the labour market gap in an Okun's Law equation) to zero on average over the sample. This may create a bias in small samples. For example, inflation rose significantly through the 1960s and 1970s, suggesting that there was excess demand over this period as a whole. Second, from a production function perspective, potential output depends on the "full employment" level of labour. An exogenous-trend specification ignores the interrelationship of potential output and the equilibrium unemployment rate. Third, a time trend ignores shifts in the growth rate of potential output stemming from changes in the growth rates of the inputs.

In earlier work at the Bank, Douglas Laxton addressed these problems. He estimated a three-equation system in which: potential output is determined by a production function, an Okun's Law equation is used to link the output and labour market gaps, and a Phillips curve is used to incorporate wage pressures. This formulation is appealing because it estimates potential output and the equilibrium rate of unemployment consistently, allows changes in capital stock and labour force behaviour to influence potential output, and brings nominal wage information to bear on the estimation of the NAIRU via

the Phillips curve. The work reported here (based on Ford and Rose) represents updated estimates using Laxton's model.[24]

Variables used to explain the NAIRU

Demographic influences (as captured by the combined labour force share of women and youth) and a measure of the generosity of the UI program (the maximum income replacement rate, adjusted by the proportion of the labour force covered by the program) have been tried as determinants of the NAIRU. The UI variable is statistically insignificant in the system estimations based on Okun's Law. According to these results, the upward trend in the NAIRU estimates is due to the rising labour force shares of youth (through 1975) and of adult women (through the entire sample). This reflects the fact that the actual unemployment rate drifted up over time, as did the female participation rate, whereas the UI variable is dominated by the major changes in 1971. It seems reasonable that the effect of these UI reforms on behaviour, and hence the NAIRU, would build through time, but it is not obvious how this should be specified for the estimation.[25]

Estimates of NAIRU

The point estimates of the NAIRU (at the end of 1987, say) depend on the specification of the equations and the sample period used. In brief, samples that include the 1982-85 recession/early recovery period yield higher NAIRU estimates than those that end in 1981. This may be due to an implicit underestimation of the severity of the recession, in that the estimator will tend to raise the NAIRU and change the parameters of the production function to lower the estimate of potential in order to track the output data better through the recession. Therefore, the model estimated on the shorter sample (and used to compute values of the NAIRU for the 1980s) may well provide more reasonable results than are generated by the model estimated over the full sample. In general, researchers have found it difficult to explain why the Canadian unemployment rate has stayed high, both absolutely and relative to the United States, during the recovery period. Estimates of the NAIRU from an unemployment equation, be it an Okun's Law or a reduced form, tend to show an increase in the 1980s because the actual unemployment rate

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24 Ford and Rose report estimates from systems containing an economy-wide Phillips curve and otherwise-similar systems with a private sector Phillips curve. We focus here on the results from the system with an economy-wide Phillips curve. There are some difficulties with the estimation of the other system, but the results are similar.

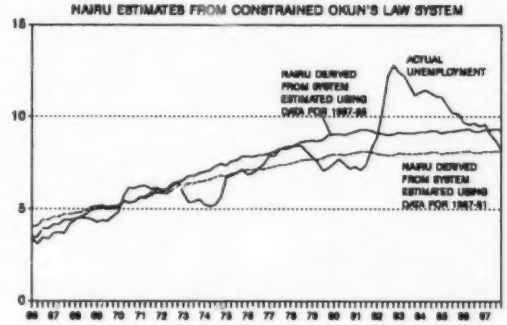
25 Laxton had some success in identifying a significant UI effect in a model that allows for lagged effects. Further work is planned to look at this issue and other possible influences, such as energy prices or the terms of trade, regional variables (dispersion of employment opportunities, cost of moving) and other aspects of the costs of or rewards from employment (e.g. taxes, non-wage benefits).

has been high and the models cannot provide other explanations as to why. This issue is discussed in more detail in the next section.

Chart 7 shows the actual unemployment rate and the system estimates of the NAIRU based on two sample periods: 1967Q1 to 1981Q4 and 1967Q1 to 1985Q4 (plus out-of-sample estimates to the end of 1987 from the two models). Using the demographic variable alone (suppressing the insignificant UI effect), the estimated NAIRU for 1987Q4 was just over 8 per cent according to the model estimated on the shorter sample, in contrast to 9.3 per cent based on the estimates from the longer sample. The implied out-of-sample estimates for 1987Q4 are almost identical to those for the period just before the recession, since the combined labour force share of adult women and youth has changed little since the early 1980s. The cross-equation restrictions necessary for the same NAIRU estimates to be generated by the Phillips curve and the Okun's Law/production function are not rejected by the data for either estimation sample. The Phillips curve tends to generate somewhat higher estimates if the restrictions are relaxed.[26]

CHART 7

NAIRU ESTIMATES FROM CONSTRAINED OKUN'S LAW SYSTEM


15
10
5
0
ACTUAL UNEMPLOYMENT
NAIRU DERIVED FROM SYSTEM ESTIMATED USING DATA FOR 1967-85
NAIRU DERIVED FROM SYSTEM ESTIMATED USING DATA FOR 1967-81
66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87

The results for the system and the Okun's Law/production function subsystem tend to be more stable in the face of changes of variable definition and estimation period than is the case for estimates obtained from the Phillips curve alone. The inclusion of the Phillips curve in the system does appear to raise the estimated NAIRU, but only slightly. By and large, it is the estimate of NAIRU from the Phillips curve that moves to conform with the estimate preferred by the Okun's Law equations.

26 The specification of the Phillips curve is similar, but not identical, to the RDXF version. Also, the data are different because here we are considering economy-wide measures as opposed to the RDXF commercial sector. The estimates of NAIRU from the unconstrained Phillips curve in this research tend to be a bit lower than those from the RDXF work.

7. A COMPARISON OF BANK OF CANADA ESTIMATES OF THE NAIRU WITH THOSE OF OTHER RESEARCHERS

The Macdonald Commission reviewed a variety of evidence and opinion on the NAIRU and reported that:

> The NAIRU is estimated to have risen from the 4 to 5 per cent range in the 1950s and early 1960s, to 6 to 7 per cent in the early 1970s, and to 6.5 to 8 per cent today.
>
> - (v. 2, pp. 284-285, September 1985)

They argued that demographic factors, which had contributed to a higher NAIRU, were likely to reduce it slowly in the future; but they also recognized that structural disturbances could be working to increase it (mainly changes in commodity prices and regional imbalances). The Commission does not discuss how it arrived at its numerical conclusions. A variety of evidence is surveyed and assembled in Volumes 1, 17 and 18 of the background research studies. The summary paper by Riddell and the individual paper by Kaliski in Volume 17 appear to be the primary sources of the Commission's views.[27]

In this section we review estimates of the Canadian NAIRU provided by other researchers, focussing on differences in methodology and their effects on the estimates. Many of the results cited are documented in Pelletier (1988). The survey provided here is not comprehensive; its main purpose is to explain why estimates from the RDXF Phillips curve are generally higher than those reported by other researchers.

7.1 The influence of how wage increases are measured

Riddell and Smith (1982) use a monthly series derived from Labour Canada's major wage settlements data in a Phillips curve incorporating UI coverage

27 The Commission argued strongly that a NAIRU in this range was unacceptably high, and went on to identify a series of policy initiatives that they felt would improve the efficiency of the economy and lower the NAIRU. These included the free-trade recommendation, reducing barriers to interprovincial trade, reform of the UI system, and a variety of other structural initiatives to improve the functioning of labour markets.

and benefits. They use a rolling ARIMA model to specify inflation expectations. They do not estimate freely the level[28] of the NAIRU, but benchmark it to 6.6 per cent in 1978, based on the work of Fortin and Phaneuf (1981). If we apply our method of calculating the NAIRU to their preferred equation, we get a value in the 12-14 per cent range, about double their 6-7 per cent.[29] The issue is how to interpret the constant in a wage equation, including the role and measurement of productivity growth. Riddell and Smith have a large estimated constant, which they treat implicitly as productivity growth or unknown sample-spécific specification error. In our methodology, any part of an estimated constant in a wage Phillips curve that cannot be directly identified as productivity growth (based on models or measures of productivity) enters the calculation of the NAIRU. We return to this key issue later in this section.

Ford and Ng (1983) also estimate Phillips curves using major wage settlements data. With the RDXF trend productivity growth, they estimate the NAIRU to be in the range of 8.4 to 8.8 per cent. This might appear to suggest that contracts data provide lower estimates of the NAIRU than do earnings data. However, in studying the effect of varying the sample period, Ford (1983) found that the parameters of the Phillips curves estimated from these data tended to be unstable.[30] As a result, estimates of the NAIRU from this approach are erratic. Therefore, we are not inclined to conclude that contracts data produce lower estimates of the NAIRU than other measures of wage changes.

7.2 The Influence of how inflation expectations are measured

We have re-estimated the Riddell-Smith wage equation in quarterly form using our wage measure, but something similar to their independently specified expected inflation and past expectation errors ("catch-up"). A standard ARIMA model rather than the rolling form of Riddell-Smith was used. We cannot reproduce all their qualitative results with our data (e.g. our catch-up term has the opposite sign). In general, however, the estimated

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28 Riddell and Smith do estimate the marginal effects of changes in UI on the NAIRU. They conclude the NAIRU jumped 1.5 percentage points in response to the 1971 UI reforms but has been relatively stable since.

29 The Riddell-Smith estimates do not impose the restrictions necessary for the accelerationist vertical Phillips curve. Strictly speaking, therefore, there is no NAIRU in their model. However, the restriction is not statistically rejected (they remark on this point) and is close to being satisfied numerically by the point estimates. Our recalculation likely overstates the NAIRU one would obtain from the model estimated under the restriction, but it is clear that the estimate would be well above that assumed by Riddell and Smith.

30 One possible reason is that the methodology used for selecting the contracts may not have ensured consistency of the sample coverage through time.

equations are like other formulations of a Phillips curve and for 1986 provide estimates of the NAIRU between 8.6 and 9.4 per cent.

If these same ARIMA expectations are used in the RDXF equation, the results are generally poor. In many variants we get the wrong sign on the unemployment gap and therefore cannot estimate the NAIRU. However, in the case where we can get an estimate, it is slightly lower than the estimate from the standard RDXF equation (with moving-average expectations).

Recall (section 5.5, Inflation expectations) that if we impose a delayed expectations structure beginning just before the 1981-82 recession, so that expected inflation stays high longer and comes down more slowly than the measure used in RDXF, we get a higher gap coefficient and an estimate of 8.4 per cent for the NAIRU, a full 2 percentage points below the RDXF estimate. How inflation expectations are measured clearly matters a great deal in this respect, and we have little useful independent information as to an appropriate specification.

7.3 The specification of productivity

Many researchers who have estimated the NAIRU have not attempted to use specific supply-side information in formulating the measure of productivity growth assumed for the exercise. Often productivity growth is assumed constant and embodied in the intercept of the regression. Our research suggests that the approach taken to the specification of productivity growth makes a great deal of difference to point estimates of the NAIRU. If we use a measure based on the supply side of RDXF for example, we tend to get systematically higher estimates of the NAIRU from the Phillips curve or from the system described in section 6. For example, recall (section 5.5, Productivity) that if we estimate the RDXF equation assuming a constant rate of growth of productivity we get an estimate of about 9.1 per cent for the NAIRU as opposed to 10.4 per cent with the model-based measure. Also, recall that our model-based measure shows total factor productivity growth below the average sample growth in output per person-hour, because it ignores the impact of the rising capital/output ratio. Although the alternative measure tends to do poorly if used as a variable in the estimation, it is still possible that the RDXF estimate of the NAIRU is biased upwards because we have not allowed for the effect of capital deepening. From the same regression that gave the 9.1 per cent NAIRU (based on sample-average RDXF productivity growth), we would get 7.7 per cent based on the alternative (APL) measure.

7.4 The use of the adult-male unemployment rate

Several researchers have argued that the unemployment rate of males aged 25 years and up has remained a reliable indicator of labour market pressure despite demographic and UI changes. They estimate Phillips curves with

this variable, compute the NAIRU for adult males, and then link the overall NAIRU to the adult-male rate (using a regression linking the actual rates of unemployment). Demographic, UI and other variables may (but do not always) enter this linking equation.

Fortin and Prud'homme (1984) use annual commercial sector wage data, the adult-male unemployment rate (adjusted by one-half of a percentage point beginning in 1973, to reflect the UI reform) and a number of variables assumed to affect wage growth (minimum wages, AIB, direct taxes). They try the productivity growth measure based on the ex post average product of labour, but it does not do well and they exclude it from their final model, embodying the effect of productivity growth in a free constant. They argue that the NAIRU for adult males is 4 to 4.3 per cent, which translates into an overall rate of 6.5 to 7 per cent, based on a simple link equation from a regression of the aggregate unemployment rate on the adult-male rate.

The adult-male rate is not calculated from Fortin and Prud'homme's estimated wage equation. If we apply our method of inferring the NAIRU to their preferred equation, using the RDXF measure of productivity growth, we get an adult-male NAIRU of 7.8 per cent, which translates into an overall NAIRU of 12.3 per cent. If we re-estimate the model using our reconstruction of their data, including revisions that have come since their study was completed, we get 6.8 per cent for the adult-male rate and 10.8 per cent for the overall NAIRU. These results are for the period 1957-82. If we use data for 1963-85, the Fortin-Prud'homme wage equation gives us 6.4 per cent for the adult-male NAIRU and 10.1 per cent for the overall NAIRU – about the same as from the RDXF equation. Using our wage or price data in the Fortin-Prud'homme equation yields quite similar results.

The use of the RDXF productivity measure in the above analysis is important. With the Fortin-Prud'homme productivity growth measure, the NAIRU estimates are lower. For example, with the revised data and the later sample period we would get a NAIRU of 5.7 per cent for adult males and 9.0 per cent for the aggregate labour force, instead of the 6.4 and 10.1 per cent figures reported above.

The effect of data frequency was tested by estimating the RDXF Phillips curve with annual data. The result, an overall NAIRU of 10.3 per cent, is very close to the 10.4 per cent estimate from quarterly data. Replacing the RDXF labour market gap with Fortin-Prud'homme's gap (adult males) yields a NAIRU for that group of 7.5 per cent, or an overall NAIRU of about 11.8 per cent based on their link equation. In the quarterly version, this number is 11.5 per cent.

The calculations of the aggregate NAIRU from re-estimated and re-interpreted Fortin-Prud'homme equations use their link equation. This gives a much greater effect of changes in the adult-male rate (on the aggregate NAIRU) than would be obtained using the more complex link equation suggested in Fortin's later (1986) work using a price equation (discussed in the next sub-section). The later equation explains more of the gap between the adult-male and aggregate rates of unemployment with other variables, and leaves a much smaller direct link between the unemployment rates. Using this equation, we would get 9.4 per cent instead of the 11.5 per cent for the aggregate NAIRU (quarterly RDXF with adult-male gap) reported above. Similarly, we would get 7.8 per cent instead of 9 per cent from the re-estimated Fortin-Prud'homme equation, calculated using the mean of their (APL) productivity growth, or 8.5 per cent instead of 10.1 calculated using the RDXF productivity measure.

In summary, the difference between our estimates and those of Fortin-Prud'homme appears to come from the measurement of productivity growth and the treatment of the estimated constant in calculating the NAIRU, and not from the frequency of the data or the particular measures of wages and prices used. The effect of estimating the wage equation with an adult-male rather than an aggregate unemployment measure depends on the choice of a link between the adult-male unemployment rate and the aggregate rate. The use of the adult-male gap in the RDXF equation lowers the estimated aggregate NAIRU if the Fortin (1986) link equation is used, but it raises the estimates if the Fortin-Prud'homme link equation is used. The choice of productivity measure has a big effect, the RDXF measure showing lower trend growth and therefore a higher estimated NAIRU. The interpretation of the constant in the estimated wage equation is also critical. Fortin and Prud'homme do not allow the presence of a constant to influence the reported NAIRU. The problem with this is that their theoretical model does not permit the existence of an independent constant. Consequently, they implicitly interpret the constant as specification or measurement error of unknown source elsewhere in the equation. The RDXF approach says that, unless some specific alternative interpretation can be offered and defended empirically, the estimation of the equation requires one to interpret trend wage growth above that explained by inflation and trend productivity as evidence that the NAIRU is above the average unemployment rate.[31] Considerable effort has been expended in seeking alternative formulations of the equation or measures of the variables that permit convincing interpretation

31 It is worth noting that in simulation of any standard macroeconomic model containing a wage Phillips curve with an independent constant, the simulated equilibrium unemployment rate would indeed reflect the constant. This assumes that the model will ensure that actual and expected inflation are eventually equal and that real wage growth must eventually satisfy a restriction derived from the production function (e.g. real wage equals marginal product in the competitive model). If there is an extra trend in wage growth in the dynamic equation, then unemployment will have to be higher to offset it. The effective equilibrium unemployment in the model therefore includes the influence of any estimated constant.

of the constant in other ways. Although this work leads us to doubt the high point estimates from standard RDXF Phillips curves, there is little support for estimates as low as suggested by Fortin and Prud'homme.

Dungan and Wilson (1982), in work for the Economic Council of Canada, report a NAIRU for the entire labour force of about 6 per cent at the end of the 1970s. This is based on an assumed (not estimated) NAIRU for adult males of 3.5-3.6 per cent, derived from lines drawn through the historical data according to the judgment of the authors as to when the economy was in excess demand or supply. They estimate links between the unemployment rates of adult males and five other segments of the labour force, using demographic and UI variables. They test the resulting weighted aggregate NAIRU by using it in a series of estimations of the FOCUS wage Phillips curve. In some results a higher adult-male rate is indicated, but the authors reject this because they do not believe the economy has been at full employment as often as the results imply.

7.5 Price equations

Fortin (1986) estimates a price equation rather than a wage equation to measure the NAIRU. Implicitly, the Phillips curve is substituted into the price equation, yielding a quasi-reduced form containing variables from both price and wage equations (Fortin does not explicitly derive the reduced form from an underlying structure). The equation relies heavily for its explanation of general inflation[32] on changes in several specific prices (energy, food, and imports excluding energy and food) and on changes in indirect taxes. Also included are *changes* in UI generosity and in the minimum wage.

Fortin uses the adult-male unemployment rate as his measure of general pressure on prices. He provides a separate equation (different from the one used in the paper with Prud'homme) to link the aggregate unemployment rate to the adult-male rate. This link permits the aggregate rate to be influenced by demographics, minimum wages, UI, etc., but only through youth and female unemployment. The adult-male unemployment rate is not influenced by these factors in Fortin's model. From these equations, Fortin estimates (i.e. here it is *not* an assumption) that the NAIRU for adult males was 4.74 per cent in 1985, while the aggregate NAIRU was 6.2 per cent.

32 The dependent variable is the rate of change of the CPI exluding food. Little explaination is offered as to why food should be excluded but not energy (the other specific price used as an explanatory variable).

In his price equation, Fortin tests for effects on inflation of *changes* in the generosity of UI and in the minimum wage. He argues that, because these variables are in first-difference form, when calculating the NAIRU one should assume that there is no change in the value and hence no contribution to the NAIRU. This would be so even if these variables were statistically significant in the regression.[33] Thus, Fortin's methodology denies the possibility of a systematic effect of changes in UI or the minimum wage on the adult NAIRU. If we re-estimate Fortin's equations with level effects from these variables, we do not obtain significant coefficients at the usual confidence levels. But the t-ratios are above one (the minimum wage variable does a bit better than the UI variable), and the implied NAIRU estimates are notably higher than reported by Fortin. For example, for 1984 the adult-male rate would be about 6 per cent and (using his link equation) the overall rate would be about 8 per cent.

There is much evidence that UI has had an effect on the male unemployment rate (see section 3 above). Measures of Canadian UI generosity are dominated by the large jump brought in by the 1971 reforms. Because there was no similar sharp rise in unemployment in the early 1970s, there is a tendency to reject the hypothesis that UI influences the NAIRU based on estimates from macroeconomic equations. Yet detailed studies of behaviour indicate the opposite. Evidently, UI disincentives take some time to have their full effect on labour-supply behaviour, or special demand factors kept the unemployment rate from rising immediately following the 1971 reforms. A recent study of Quebec labour markets (Guindon 1986) concludes that the structural male unemployment rate has indeed risen over time. In addition to UI effects, Guindon identifies a demographic effect on the male rate. According to Guindon's estimates, Quebec's adult-male structural unemployment rate rose by about 3 percentage points over Fortin's sample. These issues are far from clear, but we are not convinced by Fortin's tests that the adult-male NAIRU has remained constant through the past two decades.[34]

The explanation Fortin provides for inflation up to 1984 does not do well after that. His preferred equations predict, in static simulation, that inflation should have declined to about 2.5 per cent per annum on average over 1985-87. Moreover, his equation underpredicts inflation by increasing amounts; the error reaches 1.75 percentage points in 1987. In dynamic simulation, where these errors are cumulated through the lagged dependent variable, Fortin's equation predicts inflation close to zero in 1987. The relative price

33 For his NAIRU calculations, Fortin sets the labour market policy variables (changes in UI and minimum wages) to zero. But they are not zero on average over the sample. Thus, he does not allow any effects on the adult-male NAIRU from the historical changes in UI, etc. This arithmetic effect is small, however. With sample means for the changes we would get an adult-male NAIRU just one-third of a percentage point higher than calculated by Fortin.

34 It is worth noting that Fortin's estimate of the NAIRU for the 1960s, 5.3 - 6.0 per cent, lies well above generally accepted levels for that period (e.g. the Macdonald Commission's 4-5 per cent).

and tax terms simply cannot explain why inflation has not fallen. One possible explanation is that the NAIRU is in fact higher than Fortin's model indicates.

We have estimated equations similar to Fortin's using RDXF data and alternative measures of UI generosity and taxes. Using the RDXF specification of the labour market gap in an annual price equation with no UI variable yields estimates of the aggregate NAIRU between 7.7 and 8.1 per cent. However, if we estimate a NAIRU function using the UI variable, we get higher values -- 8.4 to 9.6 per cent at the end of the sample, 1986. It is interesting to note that in this case the UI variable works well and the demographic variables do not, contrary to the results from the Okun's Law and systems estimation. Repeating the same experiments using the adult-male unemployment rate (but still with RDXF data) and using Fortin's link equation, we obtain overall NAIRUs of 7.7 to 8.5 per cent for 1985. Without the UI variable, we get much lower results, similar to Fortin's.

We draw the following conclusions. It seems that estimates of the NAIRU from a price equation are lower than those from the RDXF wage Phillips curve. The main reason appears to be the particular measure of productivity growth used in RDXF. It is not difficult to find alternative wage equations that generate NAIRU estimates consistent with our results from price equations. However, our research does not support estimates as low as suggested by Fortin. Fortin's methodology influences his conclusions in an important way. He allows only first-difference influences from exogenous variables in his inflation equation. He thus denies the possibility of a direct link between these variables and the implied equilibrium level of the adult-male unemployment rate. Our estimation evidence shows that this is very important quantitatively for the NAIRU one obtains. Although the estimated coefficient on the UI variable is not statistically significant at the usual confidence levels in our re-estimation of Fortin's equation with his data, it usually is in our own work.

7.6 Reduced-form unemployment equations

McCallum (1987) estimates a reduced-form unemployment equation. He begins with the NAIRU suggested by Fortin from the price equation work, but recognizes that this assumption can be tested in the estimation of his model. He adds a constant and a time trend to the equation and remarks that unless these terms can be statistically restricted to zero Fortin's measure is rejected. In the general estimation, these restrictions cannot be accepted, and Fortin's measure is seen to be too low.[35] McCallum notes, however, that the rejection comes mainly from large errors in the last two years of the

35 It is worthy of note that this methodology, applied to the Fortin-Prud'homme wage equation, would lead to a similar rejection of the restriction and would suggest the higher NAIRU estimates reported above.

sample (i.e. 1984-85). Accordingly, he adds a dummy for these years and then finds that Fortin's measure cannot be rejected for the period up to 1983. This still leaves the question of how to interpret the dummy constant shift in 1984-85. McCallum notes that it might reflect a hysteresis effect or a structural adjustment effect not captured explicitly in his model. In either case these effects ought to be considered part of the NAIRU. They are not in the "deficient demand" component of unemployment McCallum identifies in his work, and there is no reason to suppose that demand stimulus could have eliminated the "unexplained" unemployment without creating inflationary pressures. We calculate that McCallum's estimates imply a NAIRU above 9 per cent in 1985, even if a share of the unexplained unemployment is allocated to the "Keynesian" component (in proportion to its share in the explained part).

McCallum criticizes earlier reduced-form work by Samson (1985), which concluded that much of the run-up in Canadian unemployment could be attributed to structural factors, captured by a Lilien dispersion measure. He argues that Samson did not control adequately for cyclical factors. It is unclear whether McCallum accepts that structural effects belong in the NAIRU, as Samson would argue, but he clearly makes the case that these effects are small in any event. He adds variables to identify the demand cycle and variables to identify the structural shocks that lie behind a dispersion of unemployment. For the latter, he tries a measure of relative resource prices (a terms-of-trade effect), a measure of relative oil prices, and a measure of relative employment in durable manufactures. Although from the structural variables only the relative resource price is significant, the Lilien-Samson dispersion measure is not significant. McCallum argues that this is because much of the unemployment labelled "structural" by Samson is really the result of deficient demand. As noted above, however, this argument does not explain well the final years of the sample.

SUMMARY TABLE:
Estimates of the NAIRU

I. METHODOLOGIES USING WAGE EQUATIONS

RDXF

current quarterly: 10.4%

annual version: 10.3%

System approach using Okun's Law

for (1987)
est. to 81Q4 8.1%
est. to 85Q4 9.3%

sensitivity analysis:
constant, RDXF productivity: 9.1%
constant, APL productivity: 7.7%
change inflation expectations: 8.4%
adult-male ugap (Fortin link): 9.4%
adult-male ugap (Prud'homme link): 11.5%

Fortin and Prud'homme with adult-male gap

original (1984): 6.5-7%

re-estimated and re-interpreted (1985)
Fortin link: 7.8%
Fortin-Prud'homme link: 9.0%

re-estimated and re-interpreted with RDXF productivity (1985)
Fortin link: 8.5%
Fortin-Prud'homme link: 10.1%

Wage contract data

Ford-Ng (1983): 8.4-8.8%

Riddell-Smith:
original (1978): 6.6%
re-interpreted (1978): 12-14%
re-estimated and re-interpreted (1986): 8.6-9.4%

II. METHODOLOGIES USING PRICE EQUATIONS

FORTIN

original (1984): 6.7%
(1985): 6.2%

re-estimated with UI variable (1984): 8%

RDXF

RDXF gap (1986): 7.7-8.1%

UI and demographic variables (1986): 8.4-9.6%

Adult-male gap and UI variable, Fortin link (1985): 7.7-8.5%

III. REDUCED-FORM UNEMPLOYMENT EQUATIONS

McCALLUM

re-interpreted (1985): 9%

8. CONCLUSIONS

Different estimates of the non-accelerating-inflation rate of unemployment (NAIRU) are presented in the summary table. It is obvious that the results are quite sensitive to methodology, to measurement of variables and to the estimation sample period. The estimate of the NAIRU produced using the structure of the Phillips curve found in the Bank of Canada's RDXF model of the Canadian economy is, at 10.4 per cent, towards the upper end of the range of estimates. However, under reasonable alternative specifications of productivity growth and inflation expectations, the same model generates estimates in the 8-9 per cent range. The work by Fortin and Prud'homme (1984), using the adult-male unemployment rate as the labour market gap measure, estimates the aggregate NAIRU to be between 6.5 and 7 per cent, which is at the lower end of the range of estimates. However, more current estimation of their model, taking into account the presence of a constant term in the equation, implies a NAIRU of around 9 per cent if their productivity measure is used or 10 per cent if the RDXF measure is used (7.8 and 8.5 based on the later Fortin link equation).

The paper reports estimates from a system approach, which involves estimating Okun's Law simultaneously with a production function and the Phillips curve. We think that this methodology for estimating the NAIRU is promising and worthy of further research. Current estimates for the 1987 NAIRU from this work are generally above 9 per cent, based on samples that extend into the 1980s, but about 8 per cent if we extrapolate using models estimated with data up to 1981.

Fortin (1986) uses a reduced-form price equation rather than a wage equation to estimate the NAIRU. This approach, which also uses the adult-male unemployment rate as an indicator of labour market tightness, tends to generate lower estimates of the NAIRU than the other approaches considered. Fortin calculates the NAIRU to be 6.2 per cent in 1985. However, his equation substantially underpredicts inflation over the 1985-87 period. One possible explanation for this, which is supported by other specifications of the price equation, is that the NAIRU is currently higher than Fortin's model suggests. Recent work by McCallum (1987) can be interpreted as supportive of this view.

The conclusion we draw from all the arguments and evidence considered is that the NAIRU (the rate of unemployment at which inflation would tend neither to accelerate nor to decelerate) was about 8 per cent at the end of 1987.

In reaching this estimate of the NAIRU, considerable judgment has been applied. The high estimates produced using the RDXF Phillips curve have been discounted. An important reason is the sensitivity of the results to details of specification, particularly the approach taken in measuring productivity growth. We are also influenced by the fact that the system estimates are generally lower, as are the estimates from price equations. It is also the case that the estimated RDXF equation, combined with a standard price mark-up equation, cannot explain why inflation has not accelerated in recent years (the opposite of the problem with Fortin's equations). One explanation is that the NAIRU is lower than suggested by the point estimates from the RDXF Phillips curve. However, this analysis does not support the very much lower estimates suggested by some other researchers. A number around 8 per cent for the end of 1987 seems to be consistent with a variety of macroeconomic evidence on the pace of price and wage changes and the degree of slack in product markets (e.g. measures of capacity utilization).

In recent years, several factors have been working to increase the NAIRU. These factors include: (i) regional imbalances caused by a combination of relative price movements and the effects of regionally extended unemployment insurance benefits; (ii) a rising ratio of UI benefits to the industrial wage; and (iii) the combined effects of rising female participation rates and the lingering problem of absorbing the "baby boom" cohort into the labour force. However, it is clear that some of these influences will become less important over the medium term, which should result in a fall in the NAIRU from current levels.

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